REPORTS OF THE 'SLEEPING SICKNESS' EXPEDITION TO THE ZAMBESI FOR THE YEARS 1907-1908

BY
ALLAN KINGHORN, M.B., TORONTO,
JOHNSTON COLONIAL FELLOW, UNIVERSITY OF LIVERPOOL
AND
R. EUSTACE MONTGOMERY, M.R.C.V.S.

OBJECTS OF THE EXPEDITION

The objects of the Expedition were to determine to what extent sleeping sickness had invaded British South African Territory, to map out the distribution of tsetse flies and to advise on means for checking the spread of sleeping sickness.

The Expedition was put under the charge of Dr. Kinghorn and Mr. Montgomery—the latter paying special attention to Trypanosomiasis in animals.

The first letter from the Expedition is dated November 22, 1907, from N'dola, North-Western Rhodesia, and is from Mr. Montgomery, relating to a correspondence between the members of the Expedition and Mr. Moffat, the local representative of the various Copper Properties in North-West Rhodesia and the General Superintendent of the Bechuanaland Coaling Co.

Mr. Moffat, who has taken a very keen interest in the sleeping sickness question, has helped the members of the Expedition in every way.

In a letter from Broken Hill, Rhodesia, dated October 23, 1907, and directed to Mr. Montgomery, Mr. Moffat states the following in regard to the question of the tsetse fly and big game:— 'I am especially keen on the question as to the connection between the game and the fly, though I am confident that there is a close connection, and that the fly will not exist long without the game, there are undoubtedly here and there spots where there is little or no game where the fly still remains. This possibly is only temporary; the fly will probably disappear from such places shortly.' Mr. Moffat then proceeds to discuss the question of establishing an Observation Camp at Broken Hill, asking for particulars of the probable cost of maintenance. In a letter dated November 21, 1907, from Broken Hill, Mr. Montgomery replied:—

'Broken Hill, Rhodesia,
'*21st November*, 1907.

'Dear Mr. Moffat,

'Your letter of 23rd ultimo reached me at N'dola. I am extremely glad that you realise the imperative needs of research into the "fly" question, for, as you will see, the success of this territory, commercial and industrial, will be extensively modified should good come of any preventative or curative measures.

'I attach herewith a short draft of what I should consider the more salient points in the projected investigation and an estimate of the probable expense. But I would ask you to clearly understand that this estimate might, after a period of work, prove quite erroneous, for, as has been noted in this district already, there are several forms of "fly" disease, and the greater the number of varieties discovered the larger the expense of experimental animals, as each would demand a separate series in the treatment and morphological researches.

'With regard to your kind suggestion that I should undertake this work should it ever receive sanction, I may say that it would be a real pleasure if it may be assumed that the question be approached in an earnest and scientific spirit, and that its inception would imply a free hand to do what was considered necessary to obtain results which would be, not only of scientific and indirect, but also of practical and direct value; but I do not wish to associate myself with any programme which would demand the waste of several months and not include in its object scientific research.

'I am positive that for such an undertaking the Liverpool School of Tropical Medicine would lend their whole support, and though I do not anticipate any movement on your side until the completion of the tour upon which I am at present engaged on their behalf, yet should arrangements be made more rapidly no difficulty would arise, for the results to be striven for are in both cases identical.

'Yours truly,

'R. C. MONTGOMERY.'

'An investigation into "fly" disease, having for its object a curative or preventative remedy, would embrace the following main points, each of which could be approached more or less independently, whilst the results of each would overlap and serve as controls to those arrived at from other sources:—

'1. The nature of the various varieties of "fly" disease parasites met with in domestic or wild animals in the territory; their effects upon domestic stock; and the action of certain selected drugs upon them, more particularly the employment of atoxyl and mercury and the use of the more easily obtained aniline dyes.

'2. The incidence of trypanosome infection in wild game; the nature and effect upon stock of the parasites found.

'3. An enquiry into the transmission of fly disease by means of biting flies, more particularly Tsetse, "Hippo" and "Blind" flies, and the "Stinging" house fly.*

'In the event of success attending the experiments at least one year would be required for thoroughly testing and proving the method of treatment; and since these would follow on those already conducted near Broken Hill, we commence from a working base which eliminates a considerable number of tentative experiments.

'The other main points would receive attention concurrently.

'It is not to be expected that this period of time is sufficient to do more than elucidate a few of the many questions associated with biting flies and big game. One could only work from hand to mouth, and from deductions drawn, institute control experiments which might answer the questions—can flies other than tsetse originate an outbreak of disease? and can flies other than tsetse continue the transmission in a herd when once originated?

'It is known that game harbour the parasite: we could only ascertain figures showing the proportion of each variety affected and the effects of these germs on domestic stock. To ascertain these with accuracy a very large number of head would require to be examined; but at any period of the investigation figures having certain values would be available.

'I would then suggest one clear year as a minimum and estimate accordingly, leaving it to be understood that in research work it is impossible to precisely specify periods of time.

'The requirements of such an investigation would be:—

'A main camp situated clear of all danger from contamination by wandering tsetse flies, in the vicinity of a plentiful water supply and grazing for experimental animals, preferably within easy reach of transport facilities and allowing of suitable accommodation for all engaged.

---

* Hippo = *Tabanus*; Blind = *Haematopota*; Stinging housefly = *Stomoxys*.

'Could such a site be found, it would be desirable to place the main camp at a spot from which tsetse fly could be obtained in sufficient numbers to permit of transmission experiments being conducted there without the necessity of erecting a second station within a fly zone and rendering that fly proof; but for treatment experiments it is a *sine quâ non* that no possible chance of re-infection, natural or accidental, should occur.

'The accommodation required would consist of (1) a laboratory building with doors and windows fitted, (2) an office room, (3) huts for the man in charge, (4) sheds for the use of both healthy and infected animals (certain of them to be rendered fly proof by means of wire mesh), (5) accommodation for all servants, (6) stores, buildings for small animals, netted runs for the same, &c., &c.

'All these could be made of timber and daub by native labour, and should not cost more than £150, excluding the imported doors and windows, the necessary gauze and wire netting, and possibly, sundry sheets of iron roofing in the event of thatch proving unsatisfactory, over either office or laboratory during the rainy season. The fittings of these buildings could be readily made from rough sawn timber, but should include at least one good case for books, papers and sensitive instruments.

'The laboratory equipment would be simple, and for ordinary purposes need not demand an initial expenditure of more than £100. Should it be found necessary to go more intimately into the morphology of either parasite or fly this amount might be doubled.

'The number of experimental animals would, of necessity, be uncertain; but, at the present moment, I consider that 50 head of cattle, 15 head of sheep and the same number of goats, 6 horses or donkeys, and several dozen dogs, monkeys, rabbits, guinea-pigs and rats would be sufficient. These would have to be obtained from a source precluding any chance of natural infection, and all precautions would have to be taken en route: factors which would slightly raise the cost.

'A vote of £500 would probably cover the purchases of all experimental animals.

'In addition, the sum of £50 should be added for the cost of incidentals and sundries in the shape of buckets, gear, ropes, stationery, petty furnishing, &c.

'For the control and the maintenance of the animals and the upkeep of the station, a capitao, 2 cattle boys and say 20 ordinary men would be needed involving a monthly expenditure of about £20.

'This indicates that the sum of £1,000 is necessary, of which 50 per cent. would be sacrificed in animals, and 25 per cent. for current expenses, but it must most clearly be understood that for the thorough investigation of such a wide field as the present subject embraces, as generous a treatment as is consistent with common sense should be given, and that a feeling of parsimony would tend to curtail necessary experimentation and seriously impair the obtaining of positive evidence which must be founded on proof derived from observation and experiments. It may be pointed out also that should no satisfactory results be obtained within the specified twelve months, only current expenses would continue until the estimated number of animals is exhausted, a circumstance which should not occur until the present views on the treatment of fly disease have been subjected to thorough test.

'For ascertaining the incidence of the fly parasite in wild game, I would suggest the establishment of sub-stations, or temporary camps, in say six districts of this territory; two at least of which should be in localities absolutely free from tsetse fly. At times convenient to the investigator, trips would be arranged to these localities and as many head of game as possible belonging to different species subjected to examination and inoculation into small animals which would be brought to the main camp for thorough observation.

'Should the main camp not be situated conveniently in regard to a plentiful supply of tsetse, a second, but more temporary, set of buildings would be required in a suitable locality. This would comprise fly-proof sheds in which to maintain both experimental animals and fly, and would involve the purchase of additional quantities of small mesh netting.

'To conclude, I would consider that a grant of £1,000 or £1,200 would enable the main points known concerning fly disease in other parts of the world to be controlled here, and to test thoroughly the present suggested methods of treatment. Should it be necessary to enter the field of research more deeply this sum might prove inadequate, and in any case, as already remarked, the investigator should be given as free a hand as possible and receive full confidence in the undertaking, and in no case should he be restricted in the event of the unforeseen occurring. To this sum would have to be added the expenses of the investigator and at least one intelligent assistant who, of necessity, need possess no qualifications.'

In the following Memorandum Mr. Montgomery furnishes Mr. Moffat with a description of the extent and nature of Trypanosomes in cattle in the Broken Hill district.

'(1) Trypanosomiasis of cattle (fly disease) is very prevalent in the vicinity of Broken Hill at the present time. On all sides information relating to losses caused is accumulating, and the disease has been verified in 36 cases.

'(2) It is possible to isolate two distinct species of Trypanosoma from these cases: the clinical effects produced upon naturally affected cattle being similar, but the reaction in inoculated animals, particularly goats and sheep, differ. Both forms are distinct from the classical cases of *T. brucei* infection found in fly disease in Zululand. It is therefore possible that further research would show a greater number of trypanosomes pathogenetic to domestic stock and that the discrepancies noted and described by hunters and travellers when referring to the effects of the tsetse fly are due to this reason.

'(3) One of these trypanosomes, closely allied to *T. dimorphon* found in Senegambia, is fatal to cattle, sheep, goats, dogs, rabbits, guinea-pigs, and rats. Two donkeys inoculated have shown no reaction. The other, possibly identical with *T. vivax* found in the Kameroons, was fatal to cattle in five of the six cases in which it was observed; the other is still living. Sheep and goats have taken the disease; but in eight experiments six appear to have recovered, two only dying (in each instance small weakly animals, which also harboured intestinal worms). Dogs, rabbits, guinea-pigs, and rats appear refractory. One donkey inoculated has shown no reaction.

'(4) Experimental treatment was adopted in most of the naturally affected cattle, and it was eventually shown that atoxyl administered in 20 per cent. solution intravenously, in doses of two three and four grammes on successive days, caused the complete disappearance of trypanosomes from the blood; they however recurred in from five to ten days, and further doses of atoxyl caused signs of poisoning.

'According to the observations of the Liverpool workers, it is surmised that mercury in the form of corrosive sublimate will prevent the recurrence, when once the trypanosomes have disappeared from the general blood stream. It has been shown that cattle will tolerate the administration of one gramme of this salt given by the mouth, in 1 in 500 solution, on three successive days. It was necessary for me to leave Broken Hill before the combination of these two drugs could be tried in these doses, but the course of the experiments indicate that the greater the amount of mercury given, the longer the period of freedom from trypanosomes in the blood, and it may be shown that even more mercury than this could be tolerated by cattle, and would be necessary to bring about absolute absence of the germs and complete cure.

'(5) No exact experiments with regard to the mode of transmission of this disease were made. Two healthy cattle were walked through a narrow fly belt, and three tsetse flies (*Glossina morsitans*) were observed to bite. Fifteen days later both showed *T. vivax* in their blood and on the eighteenth day *T. dimorphon*. This is about the normal incubative period, and I have little doubt but that they derived the double infection at the time when the tsetse flies were seen to feed.

'The investigations made into one outbreak, and all circumstances relating thereto, throw a very strong suspicion upon two species of biting flies as transmitters of this disease. These species belong to the genera *Stomoxys* (stinging house-fly) and *Lyperosia*, a very diminutive fly, similar in shape to the ordinary house fly. These two genera frequent farmyards, stables, and habitations, and breed in manure pits and dung. The former is incriminated in the natural spread of "fly disease" in Central South America and the Philippine Islands.

'Another genus of biting fly which has become excessively prevalent as I leave here is the *Tabanus*, or "gad fly." This fly is responsible for spreading "fly disease" in Algeria and India.

'(6) My brief work and observations here have shown how urgent is the need for more research into this disease which is impeding the development of the country around rail head, and how imperative it is to continue experimental work on treatment, which shows with this combination of atoxyl and mercury indications of success which have never been obtained by any previous method of treatment.

'It must be understood that these notes are merely for guidance, as it is impossible to make more dogmatic statements after so short a period of research, and that any deductions drawn therefrom are susceptible of modification.'

It will be gathered from the preceding statement that the loss from disease is increasing—that they had verified its existence in 36 cases; that they had isolated two distinct species of trypanosomes—one closely allied to *T. dimorphon*, the other possibly identical with *T. vivax*; that large doses of atoxyl were beneficial; that with regard to the question of transmission, they walked healthy cattle through a narrow fly belt, and that three tsetse (*Gl. morsitans*) were observed to bite. Fifteen days later *T. vivax* was found in their blood, and on the eighteenth day *T. dimorphon*; further, after investigating an outbreak, they concluded that there was strong suspicion that two genera of biting flies acted as transmitters—one *Stomoxys*, the other *Lyperosia*. They also conclude that *Tabanus* may take a part in transmission, as it does in Algeria and India.

The second communication is from Dr. Kinghorn and is dated December 18, 1907, at Madona, and relates to the rôle of *Gl. palpalis* and *Gl. morsitans* respectively, in the transmission of sleeping sickness, and to certain practical measures for preventing the spread of sleeping sickness.

'Madona, *December* 18, 1907.

'I left Madona on the 20th of November and went down the Luapula as far as Kazembi's, about two days south of Lake Mweru. From there I went East as far as Mshota's and then returned to this place along the Luengo river.

'I did not look for *Gl. palpalis* along the Luapula particularly, as that had already been done, and I understand from Dr. Spillane that this fly exists along a large part of its course. However, I caught specimens of *Gl. palpalis* on the bridge over the Luongo and again opposite the Johnston Falls, both places on the main road from Madona to Kalungwisi. I also got specimens of *Gl. morsitans* in a village just at the commencement of the Falls

After leaving Old Fort Rosebery, I did not see any fly along the whole of the rest of the route.

'I found two cases of trypanosomiasis on the road to Kazembi's. Both these had decidedly enlarged glands and trypanosomes were present in the gland juice. Both men had worked at Kambove. The finding of these cases is a verification of my earlier opinion that cases would be found scattered over the country among the natives who had worked in the Congo Free State.

'We have then, along the Luapula, all the factors which are necessary for an extension of the disease, i.e., cases of human trypanosomiasis and tsetse flies. *Gl. palpalis* is found chiefly along the borders of the river, but also extends for a variable distance up some of the larger affluents. *Gl. morsitans* is found more or less plentifully over most of the country immediately behind the Luapula.

'There is an impression here that *Gl. palpalis* is the only species of tsetse fly which is capable of transmitting human trypanosomiasis. As you are aware, this question has not been settled decisively; on the contrary, from the results of work done in Uganda it seems clear that species other than *Gl. palpalis* can carry the disease and also that mechanical transmission is possible. While I do not believe that mechanical transmission alone is sufficient to account for the spread of the disease, it must not be forgotten that it is a possible means, and in the light of this I am afraid I must criticise the action which is being taken here.

'The Tanganyika Concessions, Limited, have here some six to eight thousand loads which have to be carried to Kambove. Permission has been given to recruit the labour for this in British territory. A strip along the Luapula, some ten miles in width, has been declared to be infected territory. If the natives required to carry these loads to Kambove are recruited in this "infected strip," they will leave here to proceed into uninfected territory on the Congo side of the river If they are recruited outside the infected area, they will have to come into this "infected strip" for the loads. In either case natives will be moving from uninfected to infected country, or *vice versâ*. This, of course, is the one thing which should not be allowed.

'It is said that there are no *Gl. palpalis* on the route which is to be followed from here to Kambove. While this is the case, *Gl. morsitans* is very plentiful, and the width of the road which is being cut (12 feet) is not by any means sufficient to banish them. I should strongly advise that the Tanganyika Concessions, Limited, be required to move the loads across the river and to find the carriers in the Congo Free State. I was informed by Mr. MacDonald, the agent of the Tanganyika Concessions, Limited, that food is very plentiful on the Belgian side of the river, and consequently natives also, so that there should be no difficulty in getting the carriers. However, this is a matter which does not intimately concern the Administration here, except in so far as a certain amount of money would be diverted from the country. It must be clearly understood, though, that if the disease is to be prevented from getting a foothold, all commercial considerations must give way until such time as the etiology and treatment of human trypanosomiasis are on a more satisfactory basis.

'The other proposal that I feel is unjustified is one to establish a temporary segregation camp near Madona for the cases now known to exist. It is impossible to have this camp more than four or five miles distant from this station, as otherwise it would be too far away for easy access, and since natives are returning from Kambove, a medical officer is required here to examine them. The only place available within this distance, with a suitable water supply, is on the Luafumu river. Just around here, however, *Gl. morsitans* is fairly plentiful, so that there exists a risk of the disease spreading, however minimised by extensive clearing. To digress for a moment, I have a specimen of *Gl. palpalis* caught on the verandah of the assistant magistrate here, although the whole front of the river has been cleared for some distance up and down from his house (the house lies 200 yards from the river bank, which has been absolutely cleared for 400 yards in all, and beyond this cleared for gardens). Mr. Hughes, the assistant magistrate, informs me that there are places in the Luapula division eminently suited for a segregation camp, i.e., there are no tsetse flies, no villages and plenty of water. Of course until more medical men are available, some such course (i.e. a temporary segregation camp) will have to be adopted if the cases are to be treated at all, but the British South Africa Company should take steps to increase its medical staff immediately, so that the situation may be met energetically.

'In order to avoid misunderstandings, it should be clearly defined that the matter is one for which the medical officer is responsible and not the native commissioner. There is some tendency to reverse this order of things, but this should not be. The situation should be entirely under the control of the medical officer, and any assistance granted him from the native department should be subject to his direction.

'I was informed by Mr. Beringer, whom I met at Kazembi's, that the natives are crossing the northern frontier very freely. There are a lot of Swahili traders there engaged in smuggling, and these encourage native movement. An ordinance has been passed which will require these to leave the country. This of course is in accordance with the advice given by Todd some time ago, and was a very necessary proceeding. If it has not been done, I think some legislation should be passed which will enable the officials in charge of the sleeping sickness work to deal with any European who may feel disposed to ignore the regulations which have been made regarding the crossing of the borders with natives. So far as is known here, there is no penalty attached to this, so that if a European should go, say from Madona to Broken Hill through the Congo Free State, there is no means of dealing with him. In several cases special permission has been given for this to be done, and as the natives were recruited in the infected area, a dangerous precedent has been created. The Administration of North-Western Rhodesia should consider the advisability of forbidding the entrance of any native from this infected territory into its country.

'The whole question may be put thus:—As a result of the finding of *Gl. palpalis* and cases of human trypanosomiasis along the Luapula river, a strip ten miles wide bordering the stream has been declared infected territory and all movement from it stopped. Yet it is proposed to allow the Tanganyika Concessions, Limited, to move some six thousand odd loads with carriers from North-East Rhodesia through country abounding in tsetse flies to a district from which the cases now present in the country have come. In addition natives have been allowed to proceed from the infected territory through non-infected parts of the Congo Free State and North-Western Rhodesia. In view of what we know at present of the etiology of sleeping sickness, I think that this is a mistaken policy. I would urge the adoption of the following suggestions:—

'1. *The Luapula should be closed absolutely* until it has been proved definitely that *Gl. morsitans* cannot spread human trypanosomiasis. In my last letter I suggested how the river might be closed.

'2. Legislation should be provided whereby any person taking natives across the border can be prosecuted and fined.

'3. The Tanganyika Concessions, Limited, should be required to find carriers for their loads in the Congo Free State.

'4. The Administration of North-Western Rhodesia should forbid the entrance of any native into its territories from any infected area in North-Eastern Rhodesia.

'5. Segregation camps for patients should be stationed in a district free from tsetse flies of any species. In order to do this the British South Africa Company will have to increase its medical staff.

'6. The medical officer should be given charge of the work and afforded such assistance from the native department as may be necessary to carry out his instructions.

'As I have said before, I do not think that the disease has any hold on the country as yet, and if the matter is faced at once regardless of any other considerations, it can be prevented from spreading to any extent. Otherwise the danger of this is great, so far as our present knowledge extends.

'Yours faithfully,
'(Signed) ALLAN KINGHORN.'

In a letter dated Madona, January 28, 1908, to Dr. Barratt, of the Expedition which was sent out to investigate Blackwater Fever in Nyassaland, and if practicable to act in concert with the Sleeping Sickness Expedition, Dr. Kinghorn makes a statement in which he emphasises the importance of regarding all biting flies with suspicion, and states that every effort should be made to find exactly what flies, tsetse or others, are capable of carrying the virus.

'As regards "fly," *Gl. palpalis* has been found on both sides of the Luapula from Kapwepi's to Kasiwa's, a village about two days south of Lake Mweru (by Dr. Spillane and myself). It has also been found by Dr. Spillane along the whole of the British coast of Mweru, around the south end of Lake Tanganyika, and also along parts of the larger affluents of the Luapula and Kweru, notably the Mansa and the Kalungwisi. I found it on the Luongo a short distance from its mouth. From Kasiwa's to Mweru, on the British side, the Luapula is bordered by swampy plains some miles in width, so that the conditions are unfavourable for this fly. On the Belgian side, this does not obtain to such an extent, so that the fly is probably present, althougb I have no definite knowledge as to this. *Gl. morsitans*, and possibly the closely related *pallidipes* and *longipalpis*, is widely spread over the country, however. On the road from Broken Hill to Fort Jameson, I found them at one spot in the Machinga Hills, from the base of these right across the Luanga to within a day of Petauke, and near the Sasare mine. From Fort Jameson to the Luapula, they occur from the Luangwa to the base of the Machingas. There is a sudden rise here to the plateau of 2,500 feet or so, and on top of the hills I did not see fly again until I got to the Kasanka river. In this vicinity they are very plentiful, and stretch over to the Luapula and up north past Chitambo's through the country to the east of Bangweulu. They may be said to be found in most of the Luapula division.

'I have found three cases of sleeping sickness in the course of my work, all with a history of having worked in the Katanga mines. All had markedly enlarged glands, and, at the time I saw them, appeared perfectly healthy. Fly (*Gl. morsitans*) was present in the village of at least one case. Considering the thousands from this country who have worked in the Katanga mines, I am perfectly convinced that there are many more cases scattered through North-East Rhodesia, as the labour was not drawn from any one particular district.

'As you are aware, all the work which has been done goes to show that the transmission is mechanical. While I think this is not sufficient to account for the rapid spread of the disease in view of the great difficulty experienced in getting positive results, it is a fact which cannot be too strongly emphasised. There is too great a tendency to regard *Gl. palpalis* as the only infecting agent. That this is not so has been shown by the work in Uganda, where successful transmission experiments were made with *Gl. fusca*. Again the work on cattle trypanosomes shows that while one or two species are normally concerned in the extension of the disease, it is quite possible to effect this by the use of not only other species of tsetses but also other distinct genera, e.g. *Stomoxys* and *Tabanus*. This surely is sufficient to demonstrate that, at present, all biting flies, and particularly all species of *Glossina*, must be regarded with suspicion. While, perhaps, the task of controlling the spread of sleeping sickness would become impossible if every biting insect had to be considered, it is not so with regard to the tsetse flies, and I would hope that on every occasion on which you have the opportunity you would emphasise the importance of not simply regarding *Gl. palpalis* alone as dangerous. The question of the etiology of the disease is in a more unsatisfactory condition than the treatment, at all events from the prophylactic point of view, and it is most important that some definite effort should be made to find exactly what flies, tsetse and others, are capable of carrying the virus.

'As to enlarged glands, I have found that a fairly large percentage of the natives (roughly 30 to 40 per cent.) have palpable glands which come chiefly under the " + — — " group of Dutton's and Todd's classification, though there are also a number of " + — " glands. On puncture these were found to be uniformly negative. This occurrence of enlarged glands rather complicated the diagnosis, for it means that the statement "every negro with enlarged glands must be considered, until the contrary is shown, to be a ease of trypanosomiasis," cannot be accepted for North-East Rhodesia, and, presumably, for Nyassaland as well. Consequently a trained medical officer is the only person who can look for the disease satisfactorily, since puncture is necessary. I have advised that the British South Africa Company should have special medical officers to travel through the country looking for cases and getting them isolated at once. Whether it will be necessary for like measures to be taken in Nyassaland is uncertain as yet.

'The chief danger for the Protectorate lies in the spread of the disease to the north end of Lake Nyassa. Trypanosomiasis is endemic on Tanganyika at Vua in the Free State, a short distance above the Congo-Rhodesia border, and between the people on either side of this there is unrestricted communication. *Gl. palpalis* is found right round the southern end of Tanganyika, so that it is extremely probable that cases of the disease are present in that part of the country. Whether the disease is to be found in German East Africa in this neighbourhood is not known. At the north end of Nyassa *Gl. fusca* has been found, and this, we now know, can carry the disease. If once a case gets over where these flies occur an epidemic might easily be started. I believe natives of the Protectorate are carrying loads from Karonga to Kasana, and as large numbers of natives from the Awemba district of North-East Rhodesia have worked in the Katanga, cases probably exist amongst them, and the possibility of their infecting negroes from Nyassaland must not be overlooked. It therefore seems to me that the north end of Nyassa is the part which requires most attention from the authorities of the Protectorate. It would also be well to bear in mind that natives of the Protectorate have been working in the Katanga and some are only returning home now. Some of these may be infected and, in fact, I should not be at all surprised to hear at any time that cases of human trypanosomiasis had been found in Nyassaland.

'As soon as we get carriers we intend to travel across to the north end of Nyassa in order to examine the conditions there personally. We should be there in four or five months at the outside.

'Yours sincerely,
'(Signed) ALLAN KINGHORN.'

The members of the Sleeping Sickness Expedition, having seen in the 'Times' of 13/12/07 an article dealing with Game Preservation and its relation to Ngana, make the following statement:—

'THE PRESERVATION OF SOUTH AFRICAN WILD GAME.

'It may not be considered out of place for us to enter into the discussion on the subject which appeared under the above heading in the issue of the "Weekly Times" for December 13, 1907, as the article bears most directly upon the question of tsetse flies and the disease they transmit which we were dispatched by the Liverpool School of Tropical Medicine in the spring of last year to investigate on behalf of the respective Governments of British territory, North of the Zambesi.

'We hold no brief, and are actuated by no party: we merely discuss the problem from the scientific standpoint, and if sentiment sways us towards the prevention of vandalism in the works of man or nature, there is not lacking evidence which completes your correspondent's propositions and shows the danger existing. We do not presume to enter the lists on a footing with such observers as

Sir Alfred Sharpe, F. C. Selous, F. J. Jackson, or R. G. Harger, whose intimate knowledge of their respective countries and long residence there places them in a position to have personally watched the passage of events. We arrive as observers of the question as it stands to-day in the parts of the Continent over which we have travelled.

'The problem may be stated in the following paragraphs which appeared in the article mentioned:—

> '"1. . . . That certain species of tsetse fly exist only where wild game exists.
>
> '"2. That certain germs exist in the blood of wild animals, which . . . . when transferred by the tsetse . . . . are the cause of Ngana or tsetse fly disease.
>
> '"3. If therefore the propositions quoted (above) can be proved valid the game must be destroyed; there is no help for it."

'1. We have the widespread and uncontroverted statement that in many districts of South Africa the tsetse flies have disappeared; the reasons advanced being (1) the progress of civilisation, which implies the opening up of the country, the presence of men and guns, and the destruction of some game, the flight or retreat of those remaining: and (2) the epidemic of Rinderpest which swept over the country towards the middle of the last decade, killing off buffalo and antelope, and so removing the only food upon which the tsetse was held to exist.

'North of the Zambesi a precisely parallel state of affairs has obtained. Rinderpest raged, killing cattle in front and leaving the veldt strewn with carcases of game. A railway has been built, mines and mining centres opened up, and farms and mission stations are scattered over the territory, each and all implying the advent of men and guns, the destruction and the driving back of game. But the results have not been the same: wherever there is evidence that tsetse existed in the past, there it may be found to-day. Naturally we do not speak of the centre of a busy mining camp: the retreat of fly from this would be as from a native village; it is a relative and not an absolute disappearance. Further, there is much evidence that the tsetse now holds sway over roads and areas where they were unknown a few years ago.

'We are told that the tsetse of South Africa depend upon game for a living: it is true that science does not yet know for certain that this fly can obtain a living on anything but blood. Many other biting flies can maintain a vegetarian existence for a time at least, and the circumstantial evidence is certainly strong that the genus *Glossina* can do the same. In what other way can be explained the not infrequent occurrence of districts uninhabited by man and in which game, spoor or even the ordinary indications which go to make a "game country" are wanting, yet in which tsetse abound in their thousands, congregating around the traveller and his carriers in numbers impossible to ward off? An estimation of the odds against any one of these flies obtaining a meal of mammalian blood in the course of a year would indeed be work for a statistician. Further, there are districts and large areas wherein game of all local varieties is plentiful and in which no tsetse can be found. What explanation can be offered? Only that, like any other being, the members of the genus *Glossina* have their likes and dislikes, and select for a home a locality suitable according to their tastes. Even amongst the members there is individualism, for one species—*Gl. palpalis*—will not live away from the immediate vicinity of water; and only such water, too, as is open, and is bounded by defined banks which carry a sufficiency of timber or scrub to provide him with the necessary amount of shade. As every traveller in Northern Rhodesia knows, the tsetse fly of that country—*Gl. morsitans*—does not make a point of these conditions; but it does insist on shade, preferably that furnished by the half-grown trees which constitute the virgin bush, the ground between which is covered with grass, smaller trees or scrub. It does not live on an open flat, dambo or vlei, and it is quite patent that the presence of water is secondary in its estimation. From this it is obvious that there is much truth in Mr. Dunbar's suggestion that local variations in the tsetses may account for some of the discrepancies in the accounts given by various writers, for he, in turn, introduces another species of tsetse into the argument. *Gl. fusca*, the large species to which he refers, has been shown to exist at both the North and South ends of Lake Nyassa; its haunts and habits are not well known, but there is some indication that it favours similar country to *Gl. palpalis*, i.e., water and shady banks. As some species of game undoubtedly confine themselves to certain types of country, and as the tsetse is also shown capable of selective powers, may it not be that the association of fly—used without distinction of species—and particular varieties of game is but a natural inclination of both beings to the same locality, and not a peculiar affinity between the individuals?

'These statements do not answer why the tsetse (believed to have been both *Gl. morsitans* and its relative *Gl. pallidipes*) has disappeared from parts of Africa South of the Zambesi, but they go to show that game destruction by civilisation and rinderpest is not the only factor concerned. Until we are better acquainted with the bionomics of the genus *Glossina*, by observation and experiment conducted on scientific lines, the statement "that certain species of tsetse exist only where wild game exists" must remain controversial, but with a bias to the negative, if, indeed, it must not be negatived.

'2. The second of your correspondent's propositions may be dealt with in a more dogmatic fashion. ". . . . that certain germs (trypanosomes) exist in the blood of wild animals which produce in them little or no ill effect; and that these germs when transferred by the tsetse . . . are the cause of Ngana or tsetse fly disease."

'The trypanosomes of various countries all possess features in common with those of Zululand, which was shown by Bruce to be incapable of living outside an animal body, and to be spread by a biting fly, to the exclusion of all other natural means. They differ only in minor structural points, but especially in their actions upon stock. From all, death is the result in a susceptible animal, but towards some trypanosomes, cattle, towards others, camels, possess a degree of resistance approaching or equalling that enjoyed by wild game towards the Zululand form.

'As the germ cannot live in air, forage or water, it can only be derived from a pre-existing case; a reservoir, which like big game may not suffer from the disease, or an animal already sick. Bruce showed that buffalo, koodoo, wilderbeeste, bush-buck and hyaena may be that reservoir in Natal; Dutton and Todd proved that the bush-buck in the Congo Free State harboured the trypanosome of fly disease there; and in North-Western Rhodesia we have found the germ in bush-buck and Lichtenstein's hartebeest. This germ is not the same as that found by Bruce, but the sickness in cattle is identical. In North-Western Rhodesia, and when properly studied the same will probably obtain elsewhere, there is more than one species of *Trypanosoma*, and though the effects towards some animals—cattle—are the same, the action on others—goats and sheep—is different. May this, too, not account for many of the discrepancies in travellers' reports? For example, the opinions regarding the susceptibility of the donkey are very diverse; we found that this animal took one of the Rhodesian trypanosomes, whilst a second donkey did not become affected with the other form of the germ which occurs there.

'In many countries, and districts of countries too, where trypanosomiasis is rife, the amount of game is negligible. From whence does the virus, the *causa causans*, then arise? When the conditions are examined it is found that there is always at least one species of domestic animal which is more resistant than another: it may never be sick; or if it does take the disease it may live for two or three years like the camel with the Indian fly disease, and it may even recover. In South America, fly disease is seen chiefly in the horse, and cattle rarely suffer, but they, in common with the camel of India, take the place of the non-existent game, and act as a reservoir which under the required condition can issue supplies of trypanosome to all comers; causing death in those susceptible and converting the others into additional reservoirs.

'But what is the required condition without which the presence of a reservoir is not greatly to be feared? Bruce showed it to be a biting fly. In Africa travellers blamed the tsetse; in India natives incriminate the "horse fly" (*Tabanidae*), known in Rhodesia as the "hippo fly," and a smaller variety locally called "blind fly" (genus *Haematopota*); in South America and parts of Asia the "stinging house fly" (genus *Stomoxys*) is blamed.

'With few exceptions no one in South or Central Africa has even suggested the possibility of any fly other than tsetse causing the disease; and since the time when Bruce proved the connection scientifically, what was at first a mere suspicion influenced by native tales has become a conviction, to the exclusion of all other flies. It is not necessary to look far for the reason. Stock owners knew they could keep their animals around the farmstead and in certain areas with impunity, even though horse flies and the stinging house flies were present. Compared with the tsetse these other flies are "domestic"; they are limited in distribution on the veldt; their haunts and habits keep them from the free association with game that tsetse enjoy in the zones of which they and game are common residents; and they have not a fraction of the voracious nature and pertinacity possessed by the *Glossina*. On *primâ facie* grounds they cannot be incriminated to the same extent as those which live among the reservoir and which will follow an ox for miles in the hope of obtaining a meal. It is this very "domestic" nature of the other flies, however, which renders them accessories par excellence in spreading the disease when a domestic animal, controllable and housed, is the reservoir. Let the farmer in a tsetse fly country expose one of his animals until it acquires the disease and then herd it with the rest in a kraal inhabited by *Stomoxys* or other biting flies such as *Lyperosia* or *Haematobia*. The reservoir and the biting fly are present in the midst of healthy and susceptible stock; and the results have been severe enough to be well appreciated by some agriculturists in Northern Rhodesia.

'3. This second proposition is proved valid: Buffalo, Koodoo, Wildebeeste, Bush-buck, Hartebeest and Hyaena have been shown "accessories before the fact," and if we adopt your correspondent's view, they must be destroyed.

'We enter a plea that sentence may not yet be passed. To quote from the article:—"A hasty sentence of wholesale death is one whose execution, once accomplished, can never be annulled." Every month is adding to our knowledge concerning the disease in all parts of the world, and the rapid accumulation of evidence all goes to show that efficient sanitary police measures adapted to the requirements of each district, and even to each individual owner, formulated and carried into effect by an adequate staff of veterinary officers will do much to control trypanosomiasis in the domestic animals. There is no proof that the eradication of the game will be followed by the disappearance of fly disease: South Africa cannot be accepted in evidence, for the factors said to have been causative there have been without effect in other parts of the Continent. We have indicated that the destruction of the tsetse would not prevent the transmission of the germ under the conditions which obtain in countries where both game and *Glossina* are non-existent; and though it is patent that the extermination of the reservoir would, *á priori*, check the disease, we have no proof that in Central Africa a storehouse for the germ other than game may not exist.

'Irrevocable measures are not called for to satisfy the materialistic and often speculative desires of the few: for the many, a proper knowledge of the disease and the adoption of trained advice as to how it can often be avoided, may tide over the time till an effectual cure or a specific means of prevention be made known; and we earnestly urge that less draconic measures may be given a full and fair trial before the death warrant of the greatest natural attraction of Central Africa be signed.

R. EUSTACE MONTGOMERY.
ALLAN KINGHORN.

Madona, North-Eastern Rhodesia, *January 28th*, 1908.

In correspondence dated Madona, February 7th, 1908, the investigators state:—

'With regard to the report we should like to remark that we disagree with the policy of the Tanganyika Concessions, Limited, in sending loads to Kambove with natives from this country. By refusing permission to recruit labour for the mines, and still allowing loads to be taken in, we think that the Administration is placing itself in rather a false position. The Tanganyika Concessions, Limited, if required, would, we think, be able to find carriers in the Katanga as they have to do with regard to loads coming in viâ Broken Hill. They say they are taking precautions to prevent these carriers becoming infected, but these precautions only consist in cutting a road about 12 feet wide along a route in which *Gl. morsitans* is very plentiful, and by the establishment of food stations away from the villages. The natural tendency would be for the natives to try and stay in the Katanga to work, and in at least one instance a negro has run away from the gang when returning to Madona. Of course, he may not have gone back to the mines, but this is the likeliest thing, as they are paid on getting back there.

'Another rather anomalous proceeding of the local government is the official declaration of the 10 mile strip along the Luapula to be infected, so that natives come into this area on their way to Kambove, which is "uninfected." Thus we have the passage of negroes from infected to uninfected territory and *vice versâ*.

'Yours faithfully,
'ALLAN KINGHORN.

'Madona, *February 4th*, 1908.

'Dear Dr. Hearsey,

'In a recent number of the "British Medical Journal" I notice a reference to your last year's report, and as you consider the question of sleeping sickness, I should like to get a copy of it, and also of the map showing the distribution of tsetse flies, if you will kindly send them to Abercorn.

'I notice also that the road from Tanganyika to Nyassa is now unused, and that Dr. Todd's prediction as to the infection of the South end of the last-named lake has not been fulfilled. Unfortunately this is not the case. Evidence is at hand that cases now exist there, and as *Gl. palpalis* is found along its shores, the danger of a wide dissemination of the disease is great. It is not surprising that this is true, for although fly was known to exist along the Belgian side of the lake, certainly as far South as Vua, and also that imported cases were present at Moliro (1901) and Baudoinville (1902), nothing was done by the Congo authorities to check the spread of the disease, and only last year the natural consequences of this were shown by a report that the disease had become endemic at Vua. As natives on either side of the border have been communicating uninterruptedly, it would be a matter for some surprise if cases had not been brought into British territory. In German East Africa cases have been present at Ujiji, but whether there is any danger of the disease spreading southwards to the north end of Nyassa I cannot say. *Gl. palpalis* is found on the German portion of Tanganyika, certainly below Bismarckburg.

'Along the Western border here I have found three cases of trypanosomiasis, all with a history of having worked in the Katanga. I consider that these cases originated there without doubt. No indigenous cases have been found here, and as *Gl. palpalis* occurs along the whole of the Luapula from Kapwepwi's to Kasiwa's (two days south of Mweru) and the people are on the river constantly, these would have been expected had the disease been indigenous.

'As a result of the extensive importation of labour into the Katanga, cases of sleeping sickness will probably be found in all the districts from which it was drawn. This applies not only to Rhodesia but to Nyassaland as well. I am not aware how many have gone from Nyassaland, or whether they have been watched since returning, but whether or not, there is any danger of the disease coming in from the North, this route must not be forgotten. Skilled workmen and raw labour as well, from Nyassaland, are still in the Katanga. The presence in the Protectorate of *Gl. fusca*, known to be capable of transmitting *T. gambiense*, is of importance if cases are found.

'I cannot deprecate too strongly the continued permission to the Tanganyika Concessions to carry loads from Madona to Kambove with Rhodesian natives. The anomaly of this is at once apparent when it is remembered that free recruiting for the mines has been stopped. Another anomaly is that while Kambove is not regarded as being in the "infected" area of the Katanga, a strip 10 miles wide, along this side of the Luapula, has officially been declared to be infected. By allowing natives to pass, therefore, from an infected to a non-infected district the extension of the disease is inevitable. In my opinion the Luapula should be absolutely closed.

'There is a possibility of slight danger being attached to the Karonga-Kasama route. Cases of sleeping sickness will probably be found in the Awemba district of North-East Rhodesia, and tsetse-fly exists along the road in places. At present, however, I am inclined to think the danger is remote.

'When I was in Fort Jameson, Dr. Barclay told me that the results of the palpation of *all* the neck glands, not simply those in the posterior triangle, had been included in the report sent to the Colonial Office early in January (dated Zomba, January 24th, 1907). If this is correct for all the figures, they would need to be corrected. Were any of the " + " cases punctured? In view of what we have found in Rhodesia, this would be advisable. The cases I found had " + " glands, and, of course, showed the parasite (of five " + " cases seen, three were infected). Of 9,005 natives examined by me between July and December, 20·85 % had palpable glands, mostly very few in number and shotty to the touch.

'One other point on which I should like to touch is the question of what tsetse flies are able to transmit the disease. As you will know *Gl. palpalis* and *Gl. fusca* have been shown to be capable of doing so. Whether or no the other species can effect the transmission as well, is not known, but since mechanical transmission is the only method of which we have any knowledge at present, the part these may play, given the presence of cases, becomes an important consideration. Even though it should eventually be shown that the trypanosomes have a life cycle in any one tsetse fly this mechanical transmission cannot be absolutely ignored.

'Yours faithfully,

'ALLAN KINGHORN.

'The Principal Medical Officer,
'Zomba, Nyassaland.'